A Report Prepared for

Van Waters & Rogers Inc.
6100 Carillon Point
Kirkland, Washington 98033

SOIL GAS AND GROUNDWATER INVESTIGATION
FORMER VW&R FACILITY
BOISE, IDAHO

HLA Job No. 09695,335.02

by

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Division of Environmental Quality (DEQ); and measured water levels in the four DEQ monitoring wells.

1.0 INTRODUCTION

This report has been prepared for Van Waters & Rogers Inc. (VW&R) by Harding Lawson Associates (HLA) and presents the results of HLA's groundwater and soil gas investigation at the former VW&R facility. From approximately 1973 to 1983, VW&R operated a small distribution facility from a portion of a warehouse located on Friedly Drive, Boise, Idaho. Nielsen Transfer & Storage Co. (NT&S) also occupied a portion of the warehouse throughout the term of the VW&R lease. In approximately 1987 or 1988, the warehouse was removed from the site. Today, a Pier I Imports store occupies the general area where the warehouse partially occupied by VW&R was located. The current address of the Pier I Imports store is 140 Milwaukee Avenue, Boise, Idaho (Plate 1).

The objectives of the investigation were outlined in the *Work Plan, Soil Gas and Groundwater Survey, Former VW&R Facility, Boise, Idaho*, dated August 26, 1991 (*HLA, 1991*).

The objectives of this investigation were to:

- Evaluate the potential for the former VW&R facility to be a source of perchloroethene (PCE) and its degradation products trichloroethene (TCE), trans- and cis-1,2 dichloroethene (DCE), and vinyl chloride (VC) in the soil and groundwater,
- Evaluate the potential for other sources of PCE in the soil and groundwater, and
- Assess the horizontal extent of PCE in soil and groundwater downgradient of the former VW&R facility within the limits of the study area shown on Plate 1.

To meet those objectives, HLA performed a soil gas survey in the vicinity of the former VW&R facility; collected and analyzed groundwater samples from two monitoring wells previously installed by the State of Idaho, Department of Health and Welfare,

Division of Environmental Quality (DEQ); and measured water levels in the four DEQ monitoring wells.

2.0 BACKGROUND

2.1 Site Description and History

A Pier 1 Imports store and large paved parking area currently occupy the site (Plate 2). From approximately 1973 through 1983, VW&R operated a small chemical distribution facility at the Pier 1 site from a warehouse also occupied by NT&S. The property was apparently owned by a number of people during VW&R's tenancy, including NT&S, Nielsen Warehousing Co., Monteford Brooks, and Shirley O'Rielly (n/k/a Shirley O'Rielly Crowe). VW&R reportedly stored PCE in an aboveground tank at this facility. Plate 2 shows the approximate location of the former PCE tank as determined through review of historical aerial photographs. It is understood that the warehouse occupied by VW&R was taken down in late 1987 or early 1988.

Beginning in approximately 1987, the area west and north of the site has been developed. Projects include the Boise Towne Square Mall, a portion of a Walla Walla Shopping Center Associates (Walla Walla) development, other retail stores, light commercial buildings, and high density housing.

2.2 Site Hydrogeology

The shallow geology in the vicinity consists of terrace gravels 50 to 150 feet thick that have been reworked and deposited by the Boise River. The terrace gravels are generally overlain by 2 to 4 feet of engineered fill. Boring logs from two monitoring wells in the immediate vicinity of the site indicate that approximately 4 to 4.5 feet of fill are underlain by very stiff clay and silt to an approximate depth of 8 to 8.5 feet. Sand and gravel underlie the clay and silt to a depth of at least 24 feet (the total depth of the borings).

A shallow aquifer in the site vicinity is present under water table conditions at an approximate depth of 8 to 12 feet below ground surface (bgs). Localized groundwater recharge and discharge vary seasonally. Recharge generally occurs from Ridenbaugh Canal during irrigation season between April and October. However, localized groundwater discharge to the irrigation canals and sloughs has been observed in the area. Although the water table level and flow direction may fluctuate with the irrigation season, the predominant regional flow direction in this shallow aquifer is to the northwest.

3.0 FIELD INVESTIGATION

HLA's soil gas and groundwater field investigation and associated activities were conducted between September 12 and 17, 1991. The services included measuring water-levels from four existing DEQ monitoring wells (WP-1 through WP-4; Plate 2); collecting and analyzing groundwater samples from Wells WP-1 and WP-2; and conducting a soil gas survey in the vicinity of the site.

Prior to initiating field activities, access agreements were made with appropriate property owners, and utility locations were identified. Representatives of the DEQ, the U.S. Environmental Protection Agency, the City of Boise, CH2M Hill (Pier I/Pier Group's consultant) and Industrial Hygiene, Inc. (Boise Mall Development Co, Ltd.'s consultant), were present during all or some of the field activities.

3.1 Water-Level Measurements and Groundwater Sampling

On September 12, 1991, water-level measurements were obtained from Wells WP-1 through WP-4 using an electronic water-level indicator, and groundwater samples were collected from Wells WP-1 and WP-2.

Prior to sampling, each well was purged a minimum of three well volumes using a polyvinyl chloride (PVC) bailer. During well purging, water quality parameters including pH, electrical conductivity, and temperature were monitored. The purge water was contained in a 55-gallon drum. Groundwater samples were collected from the wells using dedicated stainless steel bailers. The samples were placed in 40-milliliter (ml) volatile organic analysis (VOA) vials. Split samples were collected from each well and were provided to the DEQ for their analysis. In addition, an equipment blank was collected from a decontaminated stainless steel bailer. A trip blank consisting of a laboratory-prepared water sample was shipped with the sample containers and samples

to and from the analytical laboratory. Following sample collection, the water samples were stored in a cooler at 4°C. The samples were sent under chain of custody via overnight courier to the analytical laboratory. Chain of custody records are included in Appendix C.

3.2 Groundwater Sample Analytical Program

The water samples were analyzed for volatile organic compounds (VOCs) using EPA Test Method 8010 at the Enseco Incorporated Laboratory in Sacramento, California.

3.3 Soil Gas Survey

Soil gas surveys are a reliable reconnaissance technique for identifying the approximate location of soil and groundwater contaminated by VOCs. VOCs may volatilize from contaminated soil and groundwater and move through the unsaturated zone. Analysis of soil gas samples from the unsaturated zone provides a qualitative measure of VOC concentrations in the soil and/or groundwater. Soil gas surveys are a screening tool suitable for assessing the relative concentrations of volatile compounds and provide an indication of the general area of contamination and concentration trends. However, they may not provide a direct correlation with actual concentrations in the soil and/or groundwater.

Between September 13 and 17, 1991, Hydro Geo Chem Inc. of Tucson, Arizona, evaluated the distribution of VOCs in the subsurface by conducting a soil gas survey under the supervision of HLA. The soil gas was analyzed for PCE and its degradation products TCE, trans- and cis-1,2 DCE, VC, and total hydrocarbons (THC). Thirty-four soil gas samples were collected from sample locations distributed across the study area (Plate 3).

The target sampling area, established from boring logs of Wells WP-1 and WP-2, was a gravel layer approximately 8 to 8.5 feet bgs. The sampling probes consisted of 1-3/8 inch outer diameter drill rod tipped by a hardened-steel disposable point. A truck-mounted hydraulically actuated drive point rig drove the probes into the ground to depths ranging from 5 to 11 feet bgs. Refusal was encountered at these depths due to an impenetrable layer, indicating variability in subsurface conditions.

After reaching total depth, the probe was pulled up 6 inches. A vacuum pump was used to evacuate the probe and draw soil gas vapors into the probe. A computerized mass-flow controller was used to regulate flow and measure the total volume of gas sampled. The VOCs were trapped and concentrated in sample cartridges. The sample cartridges were promptly transported to an onsite mobile laboratory for analysis.

The mobile laboratory analyzed the soil gas samples for PCE, TCE, trans-1,2 DCE, cis-1,2 DCE, VC, and THC. A description of the gas chromatographic procedure used by the mobile analytical laboratory is included in Appendix B.

Prior to sampling on each day and following equipment decontamination, atmospheric field blanks were collected and analyzed to check background contamination in the sampling system and cartridges. In addition, duplicates from 8 sampling locations were analyzed as a measure of reproducibility. The detection limit for all compounds analyzed was 0.01 micrograms per liter (μg/l).

3.4 Decontamination

To minimize the potential for cross-contamination, all sampling equipment was decontaminated prior to use and between sampling. Water-level and water sampling equipment was washed with non-phosphate detergent and water, and then "double"

4.0 RESULTS

4.1 Water-Level Measurements and Groundwater Sampling

On September 12, 1991, groundwater was encountered at depths ranging from 11.66 to 18.25 feet below the tops of the well casings. Water-level elevations for the four DEQ monitoring wells are presented in Table 1 and were used to construct the water-level contour map presented on Plate 4. Groundwater was calculated to flow toward the west-northwest at an approximate gradient of 0.001 to 0.003 ft/ft.

The groundwater samples collected from Well WP-1 contained PCE, TCE, and 1,2-DCE (cis and trans) at concentrations of 5100, 70, and 63 µg/l, respectively. Groundwater from Well WP-2 contained PCE and 1,1,1-trichloroethane (TCA) at concentrations of 6.1 and 2.0 µg/l, respectively. The results of HLA's groundwater sample analyses are presented in Table 2 and copies of the laboratory reports are included in Appendix C.

4.2 Soil Gas Survey

Table 3 presents the measured soil gas concentrations from each sampling location. Plate 5 presents PCE soil gas concentration contours detected during this investigation.

PCE was detected in 25 of the 34 samples at concentrations ranging from 0.11 to 5,500 µg/l. TCE was detected in 18 samples at concentrations ranging from 0.03 to 1,800 µg/l. Cis-1,2 DCE was detected in 10 samples at concentrations ranging from 0.6 to 540 µg/l. Total hydrocarbons were detected in all of the samples except SG-27. Total hydrocarbons concentrations ranged from 7 to 55,000 µg/l. Vinyl chloride was detected in samples collected from SG-10 and SG-11 at concentrations of 5.8 and

3.3 µg/l, respectively. Trans-1,2 DCE was detected in samples collected from SG-10 and SG-11 at concentrations of 2.2 and 0.71, respectively.

Although, ethylbenzene was not a requested analyte (it was not stored in bulk at the VW&R facility, nor handled as an industrial solvent at the VW&R facility), it was identified in the chromatograms at elevated concentrations. Ethylbenzene was detected in samples SG-10 through SG-12, and SG-14 through SG-20, at concentrations ranging from 2 to 1,200 µg/l.

Most of the soil gas samples were obtained from the gravel zone at depths ranging from 5 to 11 feet. For samples collected from this zone, approximately 2 to 5 inches of mercury vacuum were necessary to collect soil gas samples. Probes at three locations (SG-1, SG-23, SG-32) met refusal prior to reaching the target sample depth, and, therefore, may have been collected from the lower permeability layer overlying the gravel. For samples from this zone, approximately 10 to 15 inches of mercury vacuum were required to collect soil gas samples. Due to the inability to correlate data from different lithologic zones, these data have not been used for contouring (Plate 5).

In an attempt to correlate groundwater and soil gas analytical data, samples SG-1 and SG-2 were collected immediately adjacent to Wells WP-1 and WP-2, respectively. Because the soil gas sample from SG-1 was collected from the lower permeability zone overlying the gravel, no correlation of the data was possible. The soil gas sample from SG-2 contained 27 µg/l PCE. The groundwater sample collected from WP-2 contained 6.1 µg/l PCE. Correlation between groundwater and soil gas data was not possible due to the limited data available.

4.3 Quality Assurance/Quality Control

4.3.1 Groundwater Data

The accuracy of the groundwater laboratory data was assessed by evaluating internal (laboratory) spike recoveries for laboratory control samples. Laboratory control samples are laboratory method blanks that are spiked with known concentrations of chemicals by the laboratory. The accuracy of data for the water samples is acceptable. The spike recoveries ranged from 79 to 90 percent and meet quality assurance goals established by the U.S. Environmental Protection Agency (*EPA, 1986*).

To assess the precision of the data, a duplicate laboratory control sample was analyzed. Relative percent differences (RPDs) were calculated for each of the analytes where:

$$RPD = \frac{(\%\ \text{recovery Test 1} - \%\ \text{recovery Test 2})}{(\%\ \text{recovery Test 1} + \%\ \text{recovery Test 2})/2} \times 100$$

The RPDs ranged from 102 to 108 percent; all within acceptable limits.

An equipment blank and trip blank were analyzed to detect potential sample contamination. No target analytes were detected in the equipment blank, which indicates that contamination was not introduced to samples from improperly decontaminated equipment. The trip blank contained Freon 113 which indicates that some laboratory contamination of that sample did occur. However, Freon 113 was not detected in any of the other samples and was not a target analyte or compound of concern.

4.3.2 Soil Gas Data

Equipment blanks were collected and analyzed each day following equipment decontamination. Equipment blanks were used to detect potential contamination

introduced through improper field procedures. The equipment blanks were analyzed using the same procedures as the soil gas samples. Four equipment blanks were analyzed during this investigation; none contained any of the target analytes.

To evaluate the precision of the field and analytical procedures, duplicate soil gas samples were collected and analyzed from sample locations SG-01, SG-02, SG-07, SG-13, SG-14, SG-22, SG-25, and SG-32. RPDs were calculated using the following equation:

$$RPD = \frac{X_1 - X_2}{\overline{X}} \times 100$$

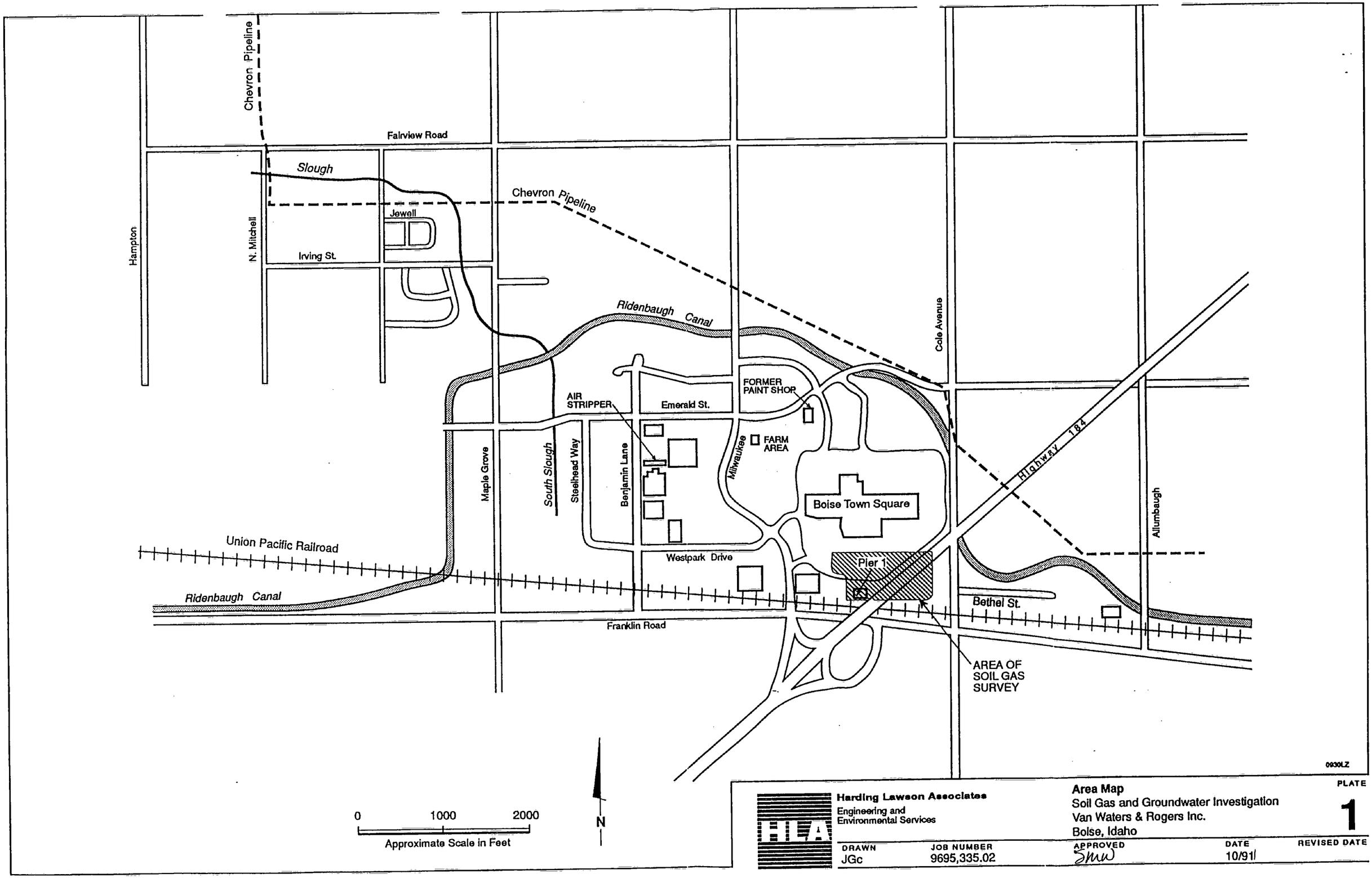
RPDs for PCE ranged from 0 to 22 percent, except for the samples from SG-13, for which the RPD was 117 percent. The average RPD for all 8 duplicate samples was 23 percent, indicating good reproducibility of data.

5.0 REFERENCES

Chen-Northern, 1991. Letter from Roger E. Braun to State of Idaho Division of Environmental Quality regarding Monthly Well Installation. July 23.

Harding Lawson Associates, 1991. *Work Plan, Soil Gas and Groundwater Survey, Former VW&R Facility, Boise, Idaho.* August 26.

U.S. Environmental Protection Agency (EPA), 1986. *Test Methods for Evaluating Solid Wastes, SW-846, Third Edition.* November.



Harding Lawson Associates
Engineering and Environmental Services

Area Map
Soil Gas and Groundwater Investigation
Van Waters & Rogers Inc.
Boise, Idaho

PLATE **1**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
JGc	9695,335.02	SMW	10/91	

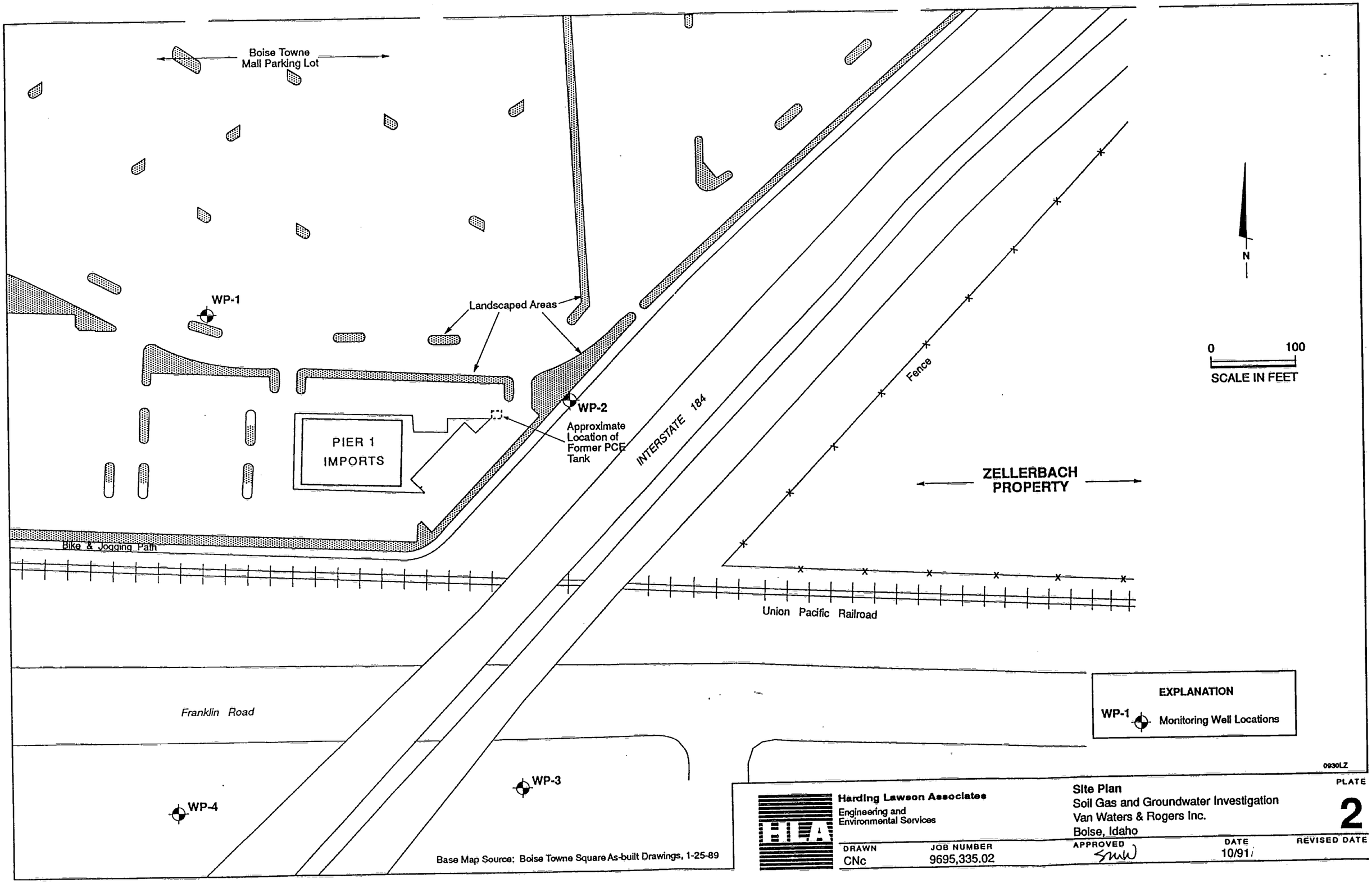


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PLATE

2

Harding Lawson Associates
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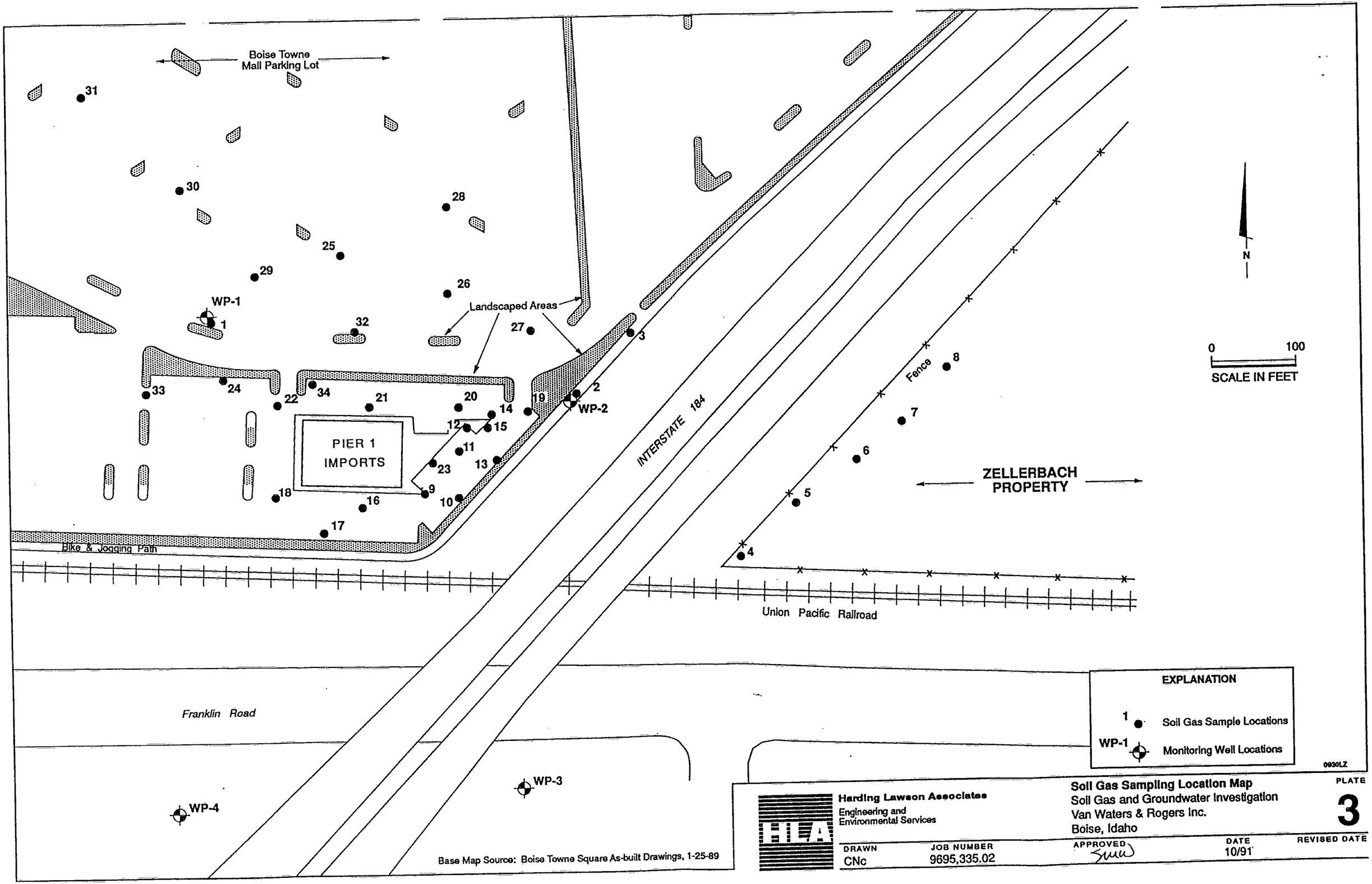
Environmental Services

Site Plan
Soil Gas and Groundwater Investigation
Van Waters & Rogers Inc.
Boise, Idaho

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
CNc	9695,335.02	SMW	10/91	



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Environmental Services

Soil Gas Sampling Location Map
Soil Gas and Groundwater Investigation
Van Waters & Rogers Inc.
Boise, Idaho

PLATE **3**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
CNc	9695,335.02		10/91	

Boise Towne
Mall Parking Lot

2686.3

WP-1
2686.34

Landscaped Areas

WP-2
2686.67

PIER 1
IMPORTS

INTERSTATE 184

Fence

ZELLERBACH
PROPERTY

N

0 100
SCALE IN FEET

Bike & Jogging Path

Union Pacific Railroad

2686.5

2686.7

2686.9

GROUNDWATER
FLOW DIRECTION

Franklin Road

WP-3
2687.01

WP-4
2686.50

Base Map Source: Boise Towne Square As-built Drawings, 1-25-89

EXPLANATION

2686.5 — Water-Level Contour, dashed where infered

2687.01 — Groundwater Elevation (feet MSL)

WP-1 — Monitoring Well Locations

0930LZ

HLA

Harding Lawson Associates
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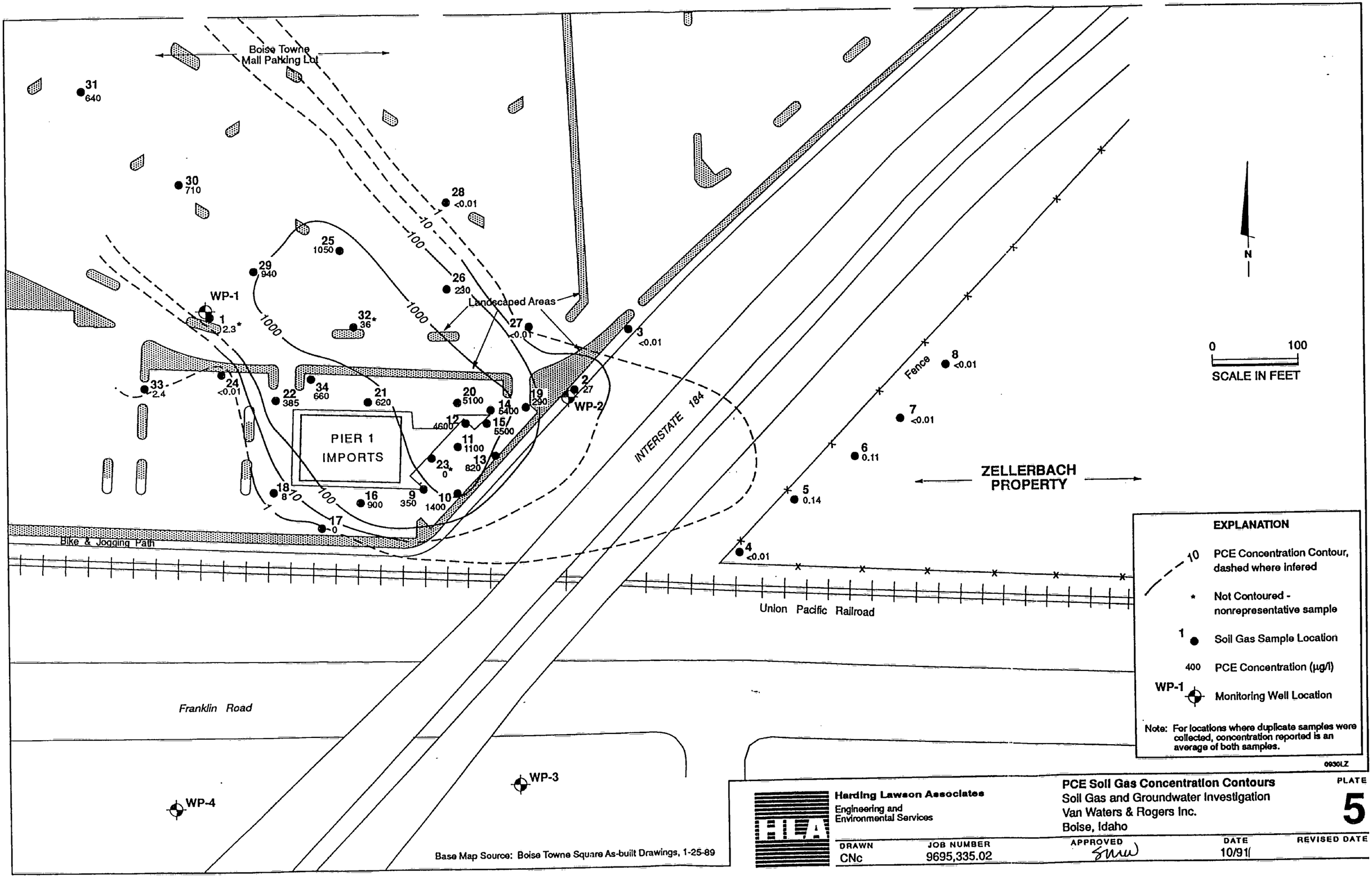
Environmental Services

Groundwater Contour Map
Soil Gas and Groundwater Investigation
Van Waters & Rogers Inc.
Boise, Idaho

PLATE **4**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
CNc	9695,335.02		10/91	



Harding Lawson Associates
Engineering and Environmental Services

PCE Soil Gas Concentration Contours
Soil Gas and Groundwater Investigation
Van Waters & Rogers Inc.
Boise, Idaho

PLATE **5**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
CNc	9695,335.02		10/91	

TABLES

Table 1. Groundwater Elevations
VW&R Boise
September 12, 1991

Well No.	Elevation TOC[1] (feet)	Depth to Water BTOC[2] (feet)	Groundwater Elevation (feet)
WP-1	2698.00	11.66	2686.34
WP-2	2699.87	13.20	2686.67
WP-3	2701.55	14.54	2687.01
WP-4	2704.75	18.25	2686.50

1 Elevation of Top of Casing; Wells surveyed by Chen-Northern (*Chen Northern, 1991*).

2 BTOC - Below top of casing.

Table 2. Groundwater Analytical Results
VW&R Boise
September 12, 1991

	Reporting Limit	91091201 WP-2	91091202 Equip. Blank	91091203 WP-1	91091204 Trip Blank
Vinyl chloride	1.0	ND[1]	ND	ND[2]	ND
1,2 Dichloroethene (DCE) (cis/trans)	0.5	ND	ND	63	ND
Trichloroethene (TCE)	0.5	ND	ND	70	ND
Perchloroethylene (PCE)	0.5	6.1	ND	5,100	ND
1,1,1 Trichloroethane (TCA)	0.5	2.0	ND	ND[2]	ND
Freon 113	1.0	ND	ND	ND	1.2[3]
Other EPA Test Method 8010 Analytes	0.5 to 2.0	ND	ND	ND[2]	ND

Note: All concentrations expressed in micrograms per liter (µg/l).

1 ND: Not detected above reporting limit.

2 Reporting limit raised due to high analyte level(s).

3 Analytical result should not be considered reliable for this common laboratory contaminant unless the sample result exceeds 5 times the reporting limit.

Table 3. Soil Gas Analytical Results
VW&R Boise
September 13-17, 1991

Sample	Depth (feet)	Vinyl Chloride (ug/l)[1]	Trans-DCE (ug/l)	Cis-DCE (ug/l)	TCE (ug/l)	PCE (ug/l)	Total Hydrocarbons (ug/l)	Other Detected Compounds (ug/l)
FB13SEP#1[2]		<0.01	<0.01	<0.01	<0.01	<0.01	<1.0	
FB15SEP#1		<0.01	<0.01	<0.01	<0.01	<0.01	<1.0	
FB16SEP#1		<0.01	<0.01	<0.01	<0.01	<0.01	<1.0	
FB16SEP#2		<0.01	<0.01	<0.01	<0.01	<0.01	<1.0	
SG-01-A	7.5	<0.01	<0.01	<0.01	0.16	2.20	25	
SG-01-B	7.5	<0.01	<0.01	<0.01	0.12	2.40	15	
SG-02-A	9.0	<0.01	<0.01	<0.01	<0.01	26.00	38	
SG-02-B	9.0	<0.01	<0.01	<0.01	0.03	28.00	42	
SG-03	9.0	<0.01	<0.01	<0.01	<0.01	<0.01	23	
SG-04	6.7	<0.01	<0.01	<0.01	<0.01	<0.01	9	
SG-05	11.0	<0.01	<0.01	<0.01	0.04	0.14	22	
SG-06	7.0	<0.01	<0.01	<0.01	<0.01	0.11	13	
SG-07-A	8.5	<0.01	<0.01	<0.01	<0.01	<0.01	10	
SG-07-B	8.5	<0.01	<0.01	<0.01	<0.01	<0.01	13	

Table 3. Soil Gas Analytical Results
VW&R Boise
September 13-17, 1991
(continued)

Sample	Depth (feet)	Vinyl Chloride (ug/l)[1]	Trans-DCE (ug/l)	Cis-DCE (ug/l)	TCE (ug/l)	PCE (ug/l)	Total Hydrocarbons (ug/l)	Other Detected Compounds (ug/l)
SG-08	5.0	<0.01	<0.01	<0.01	<0.01	<0.01	7	
SG-09	5.5	<0.01	<0.01	0.60	9.30	350.00	230	
SG-10	7.0	5.80	2.20	74.00	70.00	1,400.00	6200	Ethylbenzene (250)
SG-11	5.5	3.30	0.71	57.00	38.00	1,100.00	2600	Ethylbenzene (140)
SG-12	9.0	<0.01	<0.01	120.00	1,800.00	4,600.00	55000	Ethylbenzene (730)
SG-13-A	8.0	<0.01	<0.01	17.00	57.00	1,300.00	2,500	Unknown Aromatic
SG-13-B	8.0	<0.01	<0.01	<0.01	6.20	340.00	320	Unknown Aromatic (ND)
SG-14-A	6.5	<0.01	<0.01	290.00	170.00	5,500.00	21,000	Ethylbenzene (630)
SB-14-B	6.5	<0.01	<0.01	380.00	150.00	5,300.00	20,000	Ethylbenzene (1200)
SG-15	6.0	<0.01	<0.01	540.00	380.00	5,500.00	20,000	Ethylbenzene (830)
SG-16	9.0	<0.01	<0.01	<0.01	11.00	900.00	1400	Ethylbenzene (2)
SG-17	9.0	<0.01	<0.01	<0.01	<0.01	<0.01	60	Ethylbenzene (2)
SG-18	9.0	<0.01	<0.01	<0.01	<0.01	8.00	59	Ethylbenzene (2)

Table 3. Soil Gas Analytical Results
VW&R Boise
September 13-17, 1991
(continued)

Sample	Depth (feet)	Vinyl Chloride (ug/l)[1]	Trans-DCE (ug/l)	Cis-DCE (ug/l)	TCE (ug/l)	PCE (ug/l)	Total Hydrocarbons (ug/l)	Other Detected Compounds (ug/l)
SG-19	6.0	<0.01	<0.01	18.00	<0.01	290.00	320	Ethylbenzene (2)
SG-20	9.0	<0.01	<0.01	400.00	460.00	5,100.00	53,000	Ethylbenzene (620)
SG-21	5.5	<0.01	<0.01	<0.01	14.00	620.00	500	
SG-22-A	7.0	<0.01	<0.01	<0.01	9.10	420.00	290	
SG-22-B	7.0	<0.01	<0.01	<0.01	<0.01	350.00	220	
SB-23	7.5	<0.01	<0.01	<0.01	<0.01	<0.01	26	
SB-24	7.5	<0.01	<0.01	<0.01	<0.01	<0.01	25	
SB-25-A	5.5	<0.01	<0.01	12.00	17.00	1,100.00	1,500	
SG-25-B	5.5	<0.01	<0.01	9.40	18.00	1,000.00	1,400	
SG-26	7.0	<0.01	<0.01	<0.01	11.00	230.00	560	
SG-27	7.0	<0.01	<0.01	<0.01	<0.01	<0.01	<1.0	No Surrogate
SG-28	9.0	<0.01	<0.01	<0.01	<0.01	<0.01	37	
SG-29	9.0	<0.01	<0.01	<0.01	62.00	940.00	1100	

Table 3. Soil Gas Analytical Results
VW&R Boise
September 13-17, 1991
(continued)

Sample	Depth (feet)	Vinyl Chloride (ug/l)[1]	Trans-DCE (ug/l)	Cis-DCE (ug/l)	TCE (ug/l)	PCE (ug/l)	Total Hydrocarbons (ug/l)	Other Detected Compounds (ug/l)
SG-30	7.5	<0.01	<0.01	<0.01	<0.01	710.00	630	
SG-31	9.0	<0.01	<0.01	<0.01	<0.01	640.00	610	
SG-32-A	5.0	<0.01	<0.01	<0.01	<0.01	40.00	42	
SG-32-B	5.0	<0.01	<0.01	<0.01	<0.01	32.00	36	
SG-33	9.0	<0.01	<0.01	<0.01	<0.01	2.40	32	
SG-34	7.0	<0.01	<0.01	<0.01	18.00	660.00	600	
WATER[3]		<0.01	<0.01	<0.01	<0.01	39.00	100	

1 ug/l - micrograms per liter

2 FB13SEP#1: Field blank

3 Water sample collected from decontamination and purge water, analyzed by mobile laboratory.

Appendix A

GROUNDWATER SAMPLING FORMS

Harding Lawson Associates
Engineers and Geoscientists

GROUND-WATER SAMPLING FORM

Well No. WP-1
Well Type: ☒ Monitor ☐ Extraction ☐ Other
Well Material: ☒ PVC ☐ St. Steel ☐ Other
Date 9-12-91 Time 1100
Sampled by Sm Watson (Initials)

Job Name VWR Boise
Job Number 09695.335.02
Recorded by Sm Watson (Signature)

WELL PURGING

PURGE EQUIPMENT

Casing Diameter (D in inches):
☒ 2-inch ☐ 4-inch ☐ 6-inch ☐ Other
Total Depth of Casing (TD in feet BTOC): 23.2
Water Level Depth (WL in feet BTOC): 11.66
Number of Well Volumes to be purged (# Vols)
☒ 3 ☐ 4 ☐ 5 ☐ 10 ☐ Other

PURGE EQUIPMENT

☐ Bailer - Type:
☐ Submersible ☐ Centrifugal ☐ Bladder; Pump No.:
☐ Other - Type:

PURGE WATER DISPOSAL

☐ Near Bottom ☐ Near Top ☐ Other
Depth in feet (BTOC): _____ Screen Interval in feet (BTOC):
from _____ to _____

PURGE VOLUME CALCULATION

$$\left(\frac{23.2}{\text{TD (feet)}} - \frac{11.66}{\text{WL (feet)}}\right) \times \frac{2}{\text{D (inches)}}^{2} \times \frac{3}{\text{\# Vols}} \times 0.0408 = \frac{5.6}{\text{Calculated Purge Volume}} \text{ gallons}$$

PURGE TIME

_____ Start _____ Stop _____ Elapsed

PURGE RATE

Initial _____ gpm Final _____ gpm

ACTUAL PURGE VOLUME

_____ gallons

FIELD PARAMETER MEASUREMENTS

Minutes Since Pumping Began	pH	Cond. (µmhos/cm)	T ☐°C ☐°F	Other GAL BAILED
2	7.31	604	62.9	~1
5	7.38	616	63.5	~2
8	7.29	633	63.9	~3
10	7.31	645	64.1	~4
15	7.39	62.3	611	~5

Minutes Since Pumping Began	pH	Cond. (µmhos/cm)	T ☐°C ☐°F	Other
18	7.31	641	63.6	~6
Meter Nos.				

Observations During Purging (Well Condition, Turbidity, Color, Odor):
Discharge Water Disposal: ☐ Sanitary Sewer ☐ Storm Sewer ☒ Other 55-gal.

WELL SAMPLING

SAMPLING EQUIPMENT

☒ Bailer - Type: Stainless steel
☐ Submersible ☐ Centrifugal ☐ Bladder; Pump No.:

☐ Same As Above
☐ Grab - Type:
☐ Other - Type:

SAMPLE NUMBER PREFIX Sample Series:

Sample No.	Volume/Cont.	Analysis Requested	Preservatives	Lab	Comments
91091203	(3) VOAs	8010	HCl	ENSECO	

QUALITY CONTROL SAMPLES

Duplicate Samples

Original Sample No.	Duplicate Sample No.

Blank Samples

Type	Sample No.
EQUIP BLANK	91091202
TRIP BLANK	91091204

Other Samples

Type	Sample No.

OFFICE COPY

Harding Lawson Associates
Engineers and Geoscientists

GROUND-WATER SAMPLING FORM

Well No. WP-2
Well Type: ☒ Monitor ☐ Extraction ☐ Other
Well Material: ☒ PVC ☐ St. Steel ☐ Other
Job Name UWR Boise
Job Number 09695.335.02
Date 9-12-91 Time 1000
Recorded by S Michelle Wilson (Signature)
Sampled by SMW (Initials)

WELL PURGING

PURGE EQUIPMENT

Casing Diameter (D in inches):
☒ 2-inch ☐ 4-inch ☐ 6-inch ☐ Other
Total Depth of Casing (TD in feet BTOC): 23.2'
Water Level Depth (WL in feet BTOC): 13.21
Number of Well Volumes to be purged (# Vols)
☒ 3 ☐ 4 ☐ 5 ☐ 10 ☐ Other

PURGE PUMP

☒ Bailer - Type: PVC
☐ Submersible ☐ Centrifugal ☐ Bladder; Pump No.:
☐ Other - Type:

PURGE PUMP SET AT

☐ Near Bottom ☐ Near Top ☐ Other
Depth in feet (BTOC): Screen Interval in feet (BTOC): from to

PURGE VOLUME CALCULATION

$(23.2 - 13.21) \times 2^2 \times 3 \times 0.0408 = 4.89$ gallons

(TD (feet) − WL (feet)) × D (inches)² × # Vols × 0.0408 = Calculated Purge Volume

PURGE TIME Bailer
~~0945~~ Start 1640 Stop ____ Elapsed

PURGE RATE
Initial ____ gpm Final ____ gpm

ACTUAL PURGE VOLUME
____ gallons

FIELD PARAMETER MEASUREMENTS

Minutes Since Pumping Began	pH	Cond. (µmhos/cm)	T ☐°C ☐°F	Other
2	7.17	0.60	67	~1 gal.
5	7.32	864	62.8	~2
7	7.26	675	61.5	~4
10	7.35	575	60.5	~45
12	7.50	625	60.8	~5

Minutes Since Pumping Began	pH	Cond. (µmhos/cm)	T ☐°C ☐°F	Other
15	7.35	680	60.8	~5.3
Meter Nos.				

Observations During Purging (Well Condition, Turbidity, Color, Odor):
Discharge Water Disposal: ☐ Sanitary Sewer ☐ Storm Sewer ☒ Other 55-gal. drum

WELL SAMPLING

SAMPLE PUMP OR BAILER

☒ Bailer - Type: STAINLESS
☐ Submersible ☐ Centrifugal ☐ Bladder; Pump No.:

☐ Same As Above
☐ Grab - Type:
☐ Other - Type:

SAMPLE PUMP FLOW RATE Sample Series:

Sample No.	Volume/Cont.	Analysis Requested	Preservatives	Lab	Comments
91091201	3) VOA's	8010	Ø	ENSECO	1045

QUALITY CONTROL SAMPLES

Duplicate Samples

Original Sample No.	Duplicate Sample No.

Blank Samples

Type	Sample No.

Other Samples

Type	Sample No.

Appendix B

SOIL GAS SURVEY REPORT

SOIL GAS SURVEY
OF
THE BOISE TOWN SQUARE MALL
BOISE, IDAHO

Submitted to

Harding Lawson Associates
200 Rush Landing Road
Novato, California 94945

Submitted by

Hydro Geo Chem, Inc.
1430 North Sixth Avenue
Tucson, Arizona 85705

October 11, 1991

CONTENTS

List of Tables

INTRODUCTION

This report presents the methods and results of a soil gas investigation for volatile organic compounds performed September 13-16, 1991 at the Boise Town Square Mall in Boise, Idaho. The investigation was conducted by Hydro Geo Chem, Inc. under contract to Harding Lawson Associates. The soil gas investigation was designed to evaluate the near surface distribution of total hydrocarbons, selected aromatic hydrocarbons, and chlorinated hydrocarbons on the site.

BACKGROUND & THEORY

Soil gas surveys consist of the sampling and analysis of the soil gases that reside in the pore space of the unsaturated zone above the water table. Because many common organic compounds and industrial solvents exhibit significant vapor pressures and are relatively insoluble in water, their introduction into subsurface soils results in vapor phase permeation and transport. Should these chemicals reach the water table and travel with the groundwater, vapors will continue to emanate from the contaminated groundwater into overlying soil. Thus organic contamination of the subsurface soils and/or groundwater can be detected by measuring the concentration of volatile organics in the soil gas.

The concentration of a volatile organic compound (VOC) in soil gas is a complex function of the distribution of the organic compound and its interaction with the soil. This interaction depends on a number of soil parameters including soil particle size and

mineralogy, the soil's natural and anthropogenic organic content, soil moisture, temperature, lithology, and heterogeneity.

Whatever the source of the VOC in soil gas, its concentration is representative of soil contamination at the point of measurement. Volatile organic contaminants are present in the gas phase in unsaturated pore spaces, in the water contained in the unsaturated soils, and sorbed on the soil particles. The total soils' concentration is the sum of the VOC's contained in the three phases. The partitioning of the VOC between gas, liquid and solid phases is dependent on both the soil properties and the chemical properties of the organic compound. Thus, given the chemical properties of the VOC and measurements or reasonable estimates of relevant soil parameters, soil-gas data can be used to provide semi-quantitative estimates of soil contamination.

Since equilibrium between phases is generally rapid compared to the rate of gaseous diffusion, soil gas concentrations can be used to estimate the total soil concentration. The major uncertainties in estimating soil concentration directly from soil gas concentrations are the organic and moisture content of the soils. Chemical properties of particular organic compounds are well known, (i.e., vapor pressure, solubility), and the other relevant soil parameters (i.e., bulk density, porosity) have relatively little effect on soil concentration estimates. The following equation relates soil gas concentrations to total soil concentrations.

$$\frac{C_g}{C_T} = \left[\frac{K_D \rho_b}{H_D} + \frac{\theta_w}{H_D} + (\theta_T - \theta_w)\right]^{-1}$$

Where C_g is the concentration in the gas [M/V air]

C_T is the concentration in the soil [M/V bulk volume soil]

K_D is the water-solid distribution coefficient [M/M solid/M/V water]

ρ_b is the bulk soil density [M/V solid]

H_D is the gas-water distribution coefficient [M/V air/M/V water]

θ_w is the water filled porosity

θ_T is the total porosity

The gas-water distribution coefficient (dimensionless Henry's law constant) is

$$H_D = C_g/C_w = H/RT \approx \rho_g/S$$

where ρ_g is the saturated vapor density [M/V]

and S is the solubility [M/V].

H is the Henry's coefficient

R is the gas constant

T is the temperature in degrees Kelvin

The water-solid distribution coefficient is approximately

$$K_D = \frac{C_s}{C_w} \approx \frac{K_{oc} \cdot \%OC}{100}$$

where C_S is the concentration in the solid (mg/gm)

C_w is the concentration in the water (mg/ml)

K_{OC} is the water-organic carbon distribution coefficient

%OC is the percent organic carbon in the soil

Use of soil gas to infer concentrations of sources at distance (such as groundwater plumes) is necessarily much more qualitative. Soil gas data used in this manner is limited by the lack of information regarding the soil parameters interposed between the source and sampling point. It is therefore generally not possible to make quantitative estimates of groundwater concentrations from soil gas samples collected at distance from the saturated interface. Away from source areas (ie. underground storage tanks, surface spills etc.) where only the groundwater is providing a significant soil gas concentration, soil gas is often a relative indicator of groundwater contamination. The effectiveness of soil gas surveys to delineate groundwater contamination, is, however, dependent on the depth to groundwater, contaminant concentration in the groundwater, and distribution of air permeabilities in the unsaturated zone.

SCOPE OF WORK

Soil gas samples were collected from 34 locations on the investigation site. In addition, one sample of decontamination and purge water was collected and analyzed on-site. Sampling locations were determined by a Harding Lawson Associates on-site representative.

The volatile organic compounds that were analyzed at each of the sampling locations included the following hydrocarbons:

Tetrachloroethene (PCE)

Trichloroethene (TCE)

Trans 1,2 Dichloroethene

Cis 1,2 Dichloroethene

Chloroethene (Vinyl Chloride)

and

Total hydrocarbons

METHODS AND INSTRUMENTATION

Sampling probes consisted of 1 3/8" OD, EW drill rod tipped by a loosely held hardened-steel disposable point. A probe was driven into the ground at each sampling location to depths ranging from 5 to 11 feet below land surface using a flatbed truck-mounted hydraulically-actuated drive point rig. The probe was then pulled up 6 inches to expose the sampling interval. A regulated vacuum pump was attached to the probe via a stainless steel adaptor. Three to five times the volume of the sampling train was purged to ensure that a representative soil gas sample would be collected. The samples were collected by withdrawing the soil gas from the probe using a Hydro Geo Chem designed, computerized mass-flow controller to regulate flow and measure volume sampled. The volatile organics were trapped and concentrated in a glass cartridge contained in a stainless steel housing. The concentrating cartridge was packed with three activated carbons,

Carbotrap, Carbopak-B, and Carbosieve S-III, selected to quantitatively trap organics with widely different volatilities. After sampling, the cartridges were brought to the on-site mobile laboratory for analysis. The one water sample was obtained from a storage drum containing purge and decontaminant water by a Van Waters and Rogers on-site representative.

Gas chromatographic techniques were used to identify and measure concentrations of the various compounds. The soil gas cartridges were desorbed at a temperature of 380 °C using a thermal desorption unit. Samples were injected by the desorber into a capillary column equipped with a megabore capillary column and a photoionization (PID) and Hall conductivity detector. A split from the thermal desorber was sent to an additional gas chromatograph equipped with a flame ionization detector (FID) for analysis of total hydrocarbons (including non-priority pollutant volatile organic compounds). Total hydrocarbons were calibrated to the sum of the calibrated halogenated and aromatic hydrocarbons. Actual total hydrocarbon measurements are therefore dependent on the relative distribution of hydrocarbon compounds and their associated FID response.

Water samples were prepared for analysis by cooling the sample vial and transferring half the contents to another VOC vial. The sample volume was determined by weight. Using a purge and trap apparatus, helium was passed at 20 ml/min for 15 minutes through a needle inserted to the base of the VOC vial. The gas stream exiting from the VOC vial through another needle inserted above the water surface, purged the volatile components from the water and carried them to a carbon-packed glass trap. The cartridge was then analyzed in the same manner as the soil gas samples.

The make and model of the equipment used to perform these on-site analyses included:

Envirochem 850 Thermal Tube Desorber

Varian 3400 Gas Chromatograph

Tracor 700A Hall Detector

Tracor 703 PID Detector

Varian Flame Ionization (FID) Detector

DB 624 30m Megabore column, J.W. Scientific

DB 1 30m Megabore column, J.W. Scientific

Spectra Physics 4400 Chrom Jet Integrator

Varian 3400 Integrator

QUALITY ASSURANCE/QUALITY CONTROL

Quality control and quality assurance were achieved through strict experimental protocol. Chain of custody procedures were observed. All parts of the collection system that come in contact with a sample were cleaned before each use. A systems blank and three calibration runs were performed at the beginning of each day with additional calibration checks after every 10 samples.

Standards were prepared from stock mixtures of neat reagent grade compounds prepared by weighing each compound, addition to the mixture, and weighing an aliquot volume of the final mixture to establish density (weight/volume). For preparation of daily

standards, a measured volume of the standard mixture was injected into a nitrogen-filled 1-liter glass gas bottle through a septum side port. A measured volume of the resulting gas mixture was then injected into a 200-ml/min helium stream feeding a glass, carbon-packed concentrating cartridge. After two minutes the cartridge was transferred to the thermal desorber and analyzed exactly as the soil-gas samples.

Prior to each day's sampling, atmospheric field blanks of the entire sampling apparatus were taken and analyzed to check background contamination in the sampling system and cartridges. In addition, serial duplicates were taken from 10% of the sample locations as a measure of reproducibility.

Detection limits were 0.01 micrograms or less per liter of soil gas for all compounds analyzed, except for THC which had a detection limit of 1 microgram or less per liter soil gas. Analyses are reported to two significant figures; the minimum amount reported is 0.01 micrograms/liter. In some of the analyses, high levels of a compound may have interfered with and prevented detection of a compound present at a very low level and possessing a similar chromatographic retention time. Also, some of the lower levels of aromatic compounds may have been due to a memory effect from a previous high-concentration injection. Attempts were made to minimize this possibility by baking out the system after high concentrations had been analyzed.

RESULTS

Table 1 presents the measured soil gas concentrations from each sampling location. Concentrations, reported in micrograms per liter (µg/l) of soil gas, ranged from less than the detection limit of 0.01 µg/l to about 1,800 and 5,500 µg/l(gas) for TCE and PCE, respectively. Conversion of soil gas concentrations from µg/l (gas) to ppmV can be achieved by the following equation.

$$C_{ppmV} = C_{\mu g/l} \times RT/M_W P$$

where C_{ppmv} = soil gas concentration in ppmV

$C_{\mu g/l}$ = soil gas concentration in µg/l (gas)

R = 0.08205 L-Atm/deg-mole

T = °K

M_W = molecular wgt in grams

P = pressure in atmospheres

For most compounds C_{ppmV} is approximately 0.25 $C_{\mu g/l}$.

TABLE 1
SUMMARY OF ANALYTICAL RESULTS

SAMPLE	DEPTH FT	VCL	TDCE	CDCE	TCE	PCE	THC	COMMENT
FB13SEP#1		<0.01	<0.01	<0.01	<0.01	<0.01	<1.00	
FB15SEP#1		<0.01	<0.01	<0.01	<0.01	<0.01	<1.00	
FB16SEP#1		<0.01	<0.01	<0.01	<0.01	<0.01	<1.00	
FB16SEP#2		<0.01	<0.01	<0.01	<0.01	<0.01	<1.00	
WATER		<0.01	<0.01	<0.01	<0.01	39.00	100.00	
SG-001-A	7.5	<0.01	<0.01	<0.01	0.16	2.20	25	
SG-001-B	7.5	<0.01	<0.01	<0.01	0.12	2.40	15	
SG-002-A	9.0	<0.01	<0.01	<0.01	<0.01	26.00	38	
SG-002-B	9.0	<0.01	<0.01	<0.01	0.03	28.00	42	
SG-003	9.0	<0.01	<0.01	<0.01	<0.01	<0.01	23	
SG-004	6.7	<0.01	<0.01	<0.01	<0.01	<0.01	9	
SG-005	11.0	<0.01	<0.01	<0.01	0.04	0.14	22	
SG-006	7.0	<0.01	<0.01	<0.01	<0.01	0.11	13	
SG-007-A	8.5	<0.01	<0.01	<0.01	<0.01	<0.01	10	
SG-007-B	8.5	<0.01	<0.01	<0.01	<0.01	<0.01	13	
SG-008	5.0	<0.01	<0.01	<0.01	<0.01	<0.01	7	
SG-009	5.5	<0.01	<0.01	0.60	9.30	350.00	230	Unknown Aromatic
SG-010	7.0	5.80	2.20	74.00	70.00	1400.00	6200	Ethyl Benzene 250
SG-011	5.5	3.30	0.71	57.00	38.00	1100.00	2600	Ethyl Benzene 140
SG-012	9.0	<0.01	<0.01	120.00	1800.00	4600.00	55000	Ethyl Benzene 730
SG-013-A	8.0	<0.01	<0.01	17.00	57.00	1300.00	2500	Unknown Aromatic
SG-013-B	8.0	<0.01	<0.01	<0.01	6.20	400.00	320	Unknown Aromatic-ND
SG-014-A	6.5	<0.01	<0.01	290.00	170.00	5500.00	21000	Ethyl Benzene 630
SG-014-B	6.5	<0.01	<0.01	380.00	150.00	5300.00	20000	Ethyl Benzene 1200
SG-015	6.0	<0.01	<0.01	540.00	380.00	5500.00	20000	Ethyl Benzene 830
SG-016	9.0	<0.01	<0.01	<0.01	11.00	900.00	1400	Ethyl Benzene 2
SG-017	9.0	<0.01	<0.01	<0.01	<0.01	<0.01	60	Ethyl Benzene 2
SG-018	9.0	<0.01	<0.01	<0.01	<0.01	8.00	59	Ethyl Benzene 2
SG-019	6.0	<0.01	<0.01	18.00	<0.01	290.00	320	Ethyl Benzene 2
SG-020	9.0	<0.01	<0.01	400.00	460.00	5100.00	53000	Ethyl Benzene 640
SG-021	5.5	<0.01	<0.01	<0.01	14.00	620.00	500	
SG-022-A	7.0	<0.01	<0.01	<0.01	9.10	420.00	290	
SG-022-B	7.0	<0.01	<0.01	<0.01	<0.01	350.00	220	

TABLE 1
SUMMARY OF ANALYTICAL RESULTS (CONTINUED)

SAMPLE	DEPTH FT	VCL	TDCE	CDCE	TCE	PCE	THC	COMMENT
SG-023	7.5	<0.01	<0.01	<0.01	<0.01	<0.01	26	
SG-024	7.5	<0.01	<0.01	<0.01	<0.01	<0.01	25	
SG-025-A	5.5	<0.01	<0.01	12.00	17.00	1100.00	1500	
SG-025-B	5.5	<0.01	<0.01	9.40	18.00	1000.00	1400	
SG-026	7.0	<0.01	<0.01	<0.01	11.00	230.00	560	
SG-027	7.0	<0.01	<0.01	<0.01	<0.01	<0.0	<1.00	No Surrogate
SG-028	9.0	<0.01	<0.01	<0.01	<0.01	<0.01	37	
SG-029	9.0	<0.01	<0.01	<0.01	62.00	940.00	1100	
SG-030	7.5	<0.01	<0.01	<0.01	<0.01	710.00	630	
SG-031	9.0	<0.01	<0.01	<0.01	<0.01	640.00	610	
SG-032-A	5.0	<0.01	<0.01	<0.01	<0.01	40.00	42	
SG-032-B	5.0	<0.01	<0.01	<0.01	<0.01	32.00	36	
SG-033	9.0	<0.01	<0.01	<0.01	<0.01	2.40	32	
SG-034	7.0	<0.01	<0.01	<0.01	18.00	660.00	600	

Appendix C

LABORATORY ANALYTICAL REPORT

Enseco
A CORNING Company

September 30, 1991
Lab ID: 060423

Michelle Watson
Harding Lawson Associates
200 Rush Landing Road
Novato, CA 94945

Dear Ms. Watson:

Enclosed is the report for the four aqueous samples for your VWR Boise Project, under Job Number 09695,335.02, which were received at Enseco-Cal Lab on 13 September 1991.

The report consists of the following sections:

I	Sample Description
II	Analysis Request
III	Quality Control Report
IV	Analysis Results

If you have any questions, please feel free to call.

Sincerely,

Robert Weidenfeld
Program Administrator

svf

Enseco Incorporated
2544 Industrial Boulevard
West Sacramento, California 95691
916/372-1393 Fax: 916/372-7768

I Sample Description

See the attached Sample Description Information.

The samples were received under chain-of-custody.

II Analysis Request

The following analytical tests were requested.

Lab ID	Analysis Description
060423-1 thru 4	Halogenated Volatile Organics

III Quality Control

A. Project Specific QC. No project specific QC (i.e., spikes and/or duplicates) was requested.

B. Method Blank Results. A method blank is a laboratory-generated sample which assesses the degree to which laboratory operations and procedures cause false-positive analytical results for your samples.

No target parameters were detected in the method blanks associated with your samples at the reporting limit levels noted on the Method Blank Report.

C. Laboratory Control Samples - The LCS Program

Duplicate Control Samples. A DCS is a well-characterized matrix (blank water, sand or celite) which is spiked with certain target parameters and analyzed at approximately 10% of the sample load in order to establish method-specific control limits. The DCS results associated with your samples are on the attached Duplicate Control Sample Report.

Single Control Sample. An SCS consists of a control matrix that is spiked with surrogate compounds appropriate to the method being used. In cases where no surrogate is available, (e.g. metals or conventional analyses) a single control sample identical to the DCS serves as the control sample. An SCS is prepared for each sample lot. Accuracy is calculated identically to the DCS. The SCS results associated with your samples are on the attached Single Control Sample Report.

Accuracy is measured by Percent Recovery as in:

$$\% \text{ recovery} = \frac{\text{(measured concentration)}}{\text{(actual concentration)}} \times 100$$

Precision is measured using duplicate tests by Relative Percent Difference (RPD) as in:

$$\text{RPD} = \frac{\text{(\% recovery test 1 - \% recovery test 2)}}{\text{(\% recovery test 1 + \% recovery test 2)/2}} \times 100$$

Control limits for accuracy (percent recovery) are based on the average, historical percent recovery +/-3 standard deviation units. Control limits for precision (relative percent difference) range from 0 (identical duplicate DCS results) to the average, historical relative percent difference + 3 standard deviation units. In cases where there is not enough historical data, EPA limits or advisory limits are set, with the approval of the Quality Assurance department.

IV Analysis Results

Test methods may include minor modifications of published EPA Methods such as reporting limits or parameter lists. Reporting limits are adjusted to reflect dilution of the sample, when appropriate. Solid and waste samples are reported on an "as received" basis, i.e., no correction is made for moisture content, unless the method requires or the client requests that such correction be made.

Results are on the attached data sheets.

Enseco
A Corning Company

SAMPLE DESCRIPTION INFORMATION
for
Harding Lawson Associates Novato

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
060423-0001-SA	91091201	AQUEOUS	12 SEP 91	10:45	13 SEP 91
060423-0002-SA	91091202	AQUEOUS	12 SEP 91	11:30	13 SEP 91
060423-0003-SA	91091203	AQUEOUS	12 SEP 91	11:40	13 SEP 91
060423-0004-SA	91091204	AQUEOUS	12 SEP 91	11:50	13 SEP 91

Enseco
A Corning Company

QC LOT ASSIGNMENT REPORT
Volatile Organics by GC

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
060423-0001-SA	AQUEOUS	601-A	19 SEP 91-40A	19 SEP 91-40A
060423-0002-SA	AQUEOUS	601-A	19 SEP 91-40A	19 SEP 91-40A
060423-0003-SA	AQUEOUS	601-A	19 SEP 91-40A	23 SEP 91-38A
060423-0004-SA	AQUEOUS	601-A	19 SEP 91-40A	19 SEP 91-40A

Enseco
A Corning Company

METHOD BLANK REPORT
Volatile Organics by GC

Analyte	Result	Units	Reporting Limit
Test: 8010-A			
Matrix: AQUEOUS			
QC Lot: 19 SEP 91-40A QC Run: 19 SEP 91-40A			
Chloromethane	ND	ug/L	5.0
Bromomethane	ND	ug/L	5.0
Vinyl chloride	ND	ug/L	1.0
Chloroethane	ND	ug/L	5.0
Methylene chloride	ND	ug/L	5.0
1,1-Dichloroethene	ND	ug/L	0.50
1,1-Dichloroethane	ND	ug/L	0.50
1,2-Dichloroethene (cis/trans)	ND	ug/L	0.50
Chloroform	ND	ug/L	0.50
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	ND	ug/L	1.0
1,2-Dichloroethane	ND	ug/L	1.0
1,1,1-Trichloroethane	ND	ug/L	0.50
Carbon tetrachloride	ND	ug/L	0.50
Bromodichloromethane	ND	ug/L	1.0
1,2-Dichloropropane	ND	ug/L	1.0
trans-1,3-Dichloropropene	ND	ug/L	1.0
Trichloroethene	ND	ug/L	0.50
Dibromochloromethane	ND	ug/L	1.0
cis-1,3-Dichloropropene	ND	ug/L	2.0
1,1,2-Trichloroethane	ND	ug/L	1.0
1,2-Dibromoethane	ND	ug/L	2.0
Bromoform	ND	ug/L	5.0
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0
Tetrachloroethene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	2.0
Test: 8010-A			
Matrix: AQUEOUS			
QC Lot: 19 SEP 91-40A QC Run: 23 SEP 91-38A			
Chloromethane	ND	ug/L	5.0
Bromomethane	ND	ug/L	5.0
Vinyl chloride	ND	ug/L	1.0
Chloroethane	ND	ug/L	5.0
Methylene chloride	ND	ug/L	5.0
1,1-Dichloroethene	ND	ug/L	0.50
1,1-Dichloroethane	ND	ug/L	0.50
1,2-Dichloroethene (cis/trans)	ND	ug/L	0.50

METHOD BLANK REPORT
Volatile Organics by GC (cont.)

Test: 8010-A
Matrix: AQUEOUS
QC Lot: 19 SEP 91-40A QC Run: 23 SEP 91-38A

Analyte	Result	Units	Reporting Limit
Chloroform	ND	ug/L	0.50
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	ND	ug/L	1.0
1,2-Dichloroethane	ND	ug/L	1.0
1,1,1-Trichloroethane	ND	ug/L	0.50
Carbon tetrachloride	ND	ug/L	0.50
Bromodichloromethane	ND	ug/L	1.0
1,2-Dichloropropane	ND	ug/L	1.0
trans-1,3-Dichloropropene	ND	ug/L	1.0
Trichloroethene	ND	ug/L	0.50
Dibromochloromethane	ND	ug/L	1.0
cis-1,3-Dichloropropene	ND	ug/L	2.0
1,1,2-Trichloroethane	ND	ug/L	1.0
1,2-Dibromoethane	ND	ug/L	2.0
Bromoform	ND	ug/L	5.0
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0
Tetrachloroethene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	2.0

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DUPLICATE CONTROL SAMPLE REPORT
Volatile Organics by GC

Analyte	Concentration Spiked	Measured DCS1	Measured DCS2	AVG	Accuracy Average(%) DCS	Accuracy Limits	Precision (RPD) DCS	Precision Limit
Category: 601-A								
Matrix: AQUEOUS								
QC Lot: 19 SEP 91-40A								
Concentration Units: ug/l								
1,1-Dichloroethane	5.0	5.27	5.21	5.24	105	82-118	1.1	12
Chloroform	5.0	5.36	5.04	5.20	104	46-155	6.2	14
Bromodichloromethane	5.0	5.30	4.97	5.14	103	77-123	6.4	12
Trichloroethene	5.0	5.25	4.94	5.10	102	73-118	6.1	10
Chlorobenzene	5.0	5.46	5.32	5.39	108	66-123	2.6	13

Calculations are performed before rounding to avoid round-off errors in calculated results.

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SINGLE CONTROL SAMPLE REPORT
Volatile Organics by GC

Analyte	Concentration Spiked	Measured	Accuracy(%) SCS	Limits
Category: 601-A Matrix: AQUEOUS QC Lot: 19 SEP 91-40A QC Run: 19 SEP 91-40A Concentration Units: ug/l				
Bromochloromethane	4.00	3.74	94	49-125
Category: 601-A Matrix: AQUEOUS QC Lot: 19 SEP 91-40A QC Run: 23 SEP 91-38A Concentration Units: ug/l				
Bromochloromethane	4.00	3.32	83	49-125

Calculations are performed before rounding to avoid round-off errors in calculated results.

Enseco
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Halogenated Volatile Organics

Method 8010

Client Name: Harding Lawson Associates Novato
Client ID: 91091201
Lab ID: 060423-0001-SA
Matrix: AQUEOUS Sampled: 12 SEP 91 Received: 13 SEP 91
Authorized: 13 SEP 91 Prepared: NA Analyzed: 19 SEP 91

Parameter	Result	Units	Reporting Limit
Chloromethane	ND	ug/L	5.0
Bromomethane	ND	ug/L	5.0
Vinyl chloride	ND	ug/L	1.0
Chloroethane	ND	ug/L	5.0
Methylene chloride	ND	ug/L	5.0
1,1-Dichloroethene	ND	ug/L	0.50
1,1-Dichloroethane	ND	ug/L	0.50
1,2-Dichloroethene (cis/trans)	ND	ug/L	0.50
Chloroform	ND	ug/L	0.50
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	ND	ug/L	1.0
1,2-Dichloroethane	ND	ug/L	1.0
1,1,1-Trichloroethane	2.0	ug/L	0.50
Carbon tetrachloride	ND	ug/L	0.50
Bromodichloromethane	ND	ug/L	1.0
1,2-Dichloropropane	ND	ug/L	1.0
trans-1,3-Dichloropropene	ND	ug/L	1.0
Trichloroethene	ND	ug/L	0.50
Dibromochloromethane	ND	ug/L	1.0
cis-1,3-Dichloropropene	ND	ug/L	2.0
1,1,2-Trichloroethane	ND	ug/L	1.0
1,2-Dibromoethane	ND	ug/L	2.0
Bromoform	ND	ug/L	5.0
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0
Tetrachloroethene	6.1	ug/L	0.50
Chlorobenzene	ND	ug/L	2.0

Surrogate	Recovery	
Bromochloromethane	79	%

ND = Not detected
NA = Not applicable

Reported By: Jennifer Neeley Bavetta Approved By: Marcia Reed

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Enseco
A Corning Company

Halogenated Volatile Organics

Method 8010

Client Name: Harding Lawson Associates Novato
Client ID: 91091202
Lab ID: 060423-0002-SA
Matrix: AQUEOUS Sampled: 12 SEP 91 Received: 13 SEP 91
Authorized: 13 SEP 91 Prepared: NA Analyzed: 19 SEP 91

Parameter	Result	Units	Reporting Limit
Chloromethane	ND	ug/L	5.0
Bromomethane	ND	ug/L	5.0
Vinyl chloride	ND	ug/L	1.0
Chloroethane	ND	ug/L	5.0
Methylene chloride	ND	ug/L	5.0
1,1-Dichloroethene	ND	ug/L	0.50
1,1-Dichloroethane	ND	ug/L	0.50
1,2-Dichloroethene (cis/trans)	ND	ug/L	0.50
Chloroform	ND	ug/L	0.50
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	ND	ug/L	1.0
1,2-Dichloroethane	ND	ug/L	1.0
1,1,1-Trichloroethane	ND	ug/L	0.50
Carbon tetrachloride	ND	ug/L	0.50
Bromodichloromethane	ND	ug/L	1.0
1,2-Dichloropropane	ND	ug/L	1.0
trans-1,3-Dichloropropene	ND	ug/L	1.0
Trichloroethene	ND	ug/L	0.50
Dibromochloromethane	ND	ug/L	1.0
cis-1,3-Dichloropropene	ND	ug/L	2.0
1,1,2-Trichloroethane	ND	ug/L	1.0
1,2-Dibromoethane	ND	ug/L	2.0
Bromoform	ND	ug/L	5.0
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0
Tetrachloroethene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	2.0

Surrogate	Recovery	
Bromochloromethane	87	%

ND = Not detected
NA = Not applicable

Reported By: Jennifer Neeley Bavetta Approved By: Marcia Reed

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Halogenated Volatile Organics

Method 8010

Client Name: Harding Lawson Associates Novato
Client ID: 91091203
Lab ID: 060423-0003-SA
Matrix: AQUEOUS Sampled: 12 SEP 91 Received: 13 SEP 91
Authorized: 13 SEP 91 Prepared: NA Analyzed: 23 SEP 91

Parameter	Result	Units	Reporting Limit	
Chloromethane	ND	ug/L	100	R
Bromomethane	ND	ug/L	100	
Vinyl chloride	ND	ug/L	100	
Chloroethane	ND	ug/L	100	
Methylene chloride	ND	ug/L	100	
1,1-Dichloroethene	ND	ug/L	50	
1,1-Dichloroethane	ND	ug/L	50	
1,2-Dichloroethene (cis/trans)	63	ug/L	50	
Chloroform	ND	ug/L	50	
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	ND	ug/L	50	
1,2-Dichloroethane	ND	ug/L	50	
1,1,1-Trichloroethane	ND	ug/L	50	
Carbon tetrachloride	ND	ug/L	50	
Bromodichloromethane	ND	ug/L	50	
1,2-Dichloropropane	ND	ug/L	50	
trans-1,3-Dichloropropene	ND	ug/L	50	
Trichloroethene	70	ug/L	50	
Dibromochloromethane	ND	ug/L	50	
cis-1,3-Dichloropropene	ND	ug/L	60	
1,1,2-Trichloroethane	ND	ug/L	50	
1,2-Dibromoethane	ND	ug/L	50	
Bromoform	ND	ug/L	50	
1,1,2,2-Tetrachloroethane	ND	ug/L	50	
Tetrachloroethene	5100	ug/L	50	
Chlorobenzene	ND	ug/L	50	

Surrogate	Recovery	
Bromochloromethane	90	%

Note R : Raised reporting limit(s) due to high analyte level(s).

ND = Not detected
NA = Not applicable

Reported By: Jennifer Neeley Bavetta Approved By: Marcia Reed

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Enseco
A Corning Company

Halogenated Volatile Organics

Method 8010

Client Name: Harding Lawson Associates Novato
Client ID: 91091204
Lab ID: 060423-0004-SA
Matrix: AQUEOUS Sampled: 12 SEP 91 Received: 13 SEP 91
Authorized: 13 SEP 91 Prepared: NA Analyzed: 19 SEP 91

Parameter	Result	Units	Reporting Limit	
Chloromethane	ND	ug/L	5.0	
Bromomethane	ND	ug/L	5.0	
Vinyl chloride	ND	ug/L	1.0	
Chloroethane	ND	ug/L	5.0	
Methylene chloride	ND	ug/L	5.0	
1,1-Dichloroethene	ND	ug/L	0.50	
1,1-Dichloroethane	ND	ug/L	0.50	
1,2-Dichloroethene (cis/trans)	ND	ug/L	0.50	
Chloroform	ND	ug/L	0.50	
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	1.2	ug/L	1.0	b
1,2-Dichloroethane	ND	ug/L	1.0	
1,1,1-Trichloroethane	ND	ug/L	0.50	
Carbon tetrachloride	ND	ug/L	0.50	
Bromodichloromethane	ND	ug/L	1.0	
1,2-Dichloropropane	ND	ug/L	1.0	
trans-1,3-Dichloropropene	ND	ug/L	1.0	
Trichloroethene	ND	ug/L	0.50	
Dibromochloromethane	ND	ug/L	1.0	
cis-1,3-Dichloropropene	ND	ug/L	2.0	
1,1,2-Trichloroethane	ND	ug/L	1.0	
1,2-Dibromoethane	ND	ug/L	2.0	
Bromoform	ND	ug/L	5.0	
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0	
Tetrachloroethene	ND	ug/L	0.50	
Chlorobenzene	ND	ug/L	2.0	

Surrogate	Recovery	
Bromochloromethane	90	%

Note b : Analytical results should not be considered reliable for this common lab contaminant unless the sample result exceeds 5 times the reporting limit or 10 times the blank result.

ND = Not detected
NA = Not applicable

Reported By: Jennifer Neeley Bavetta Approved By: Marcia Reed

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Harding Lawson Associates
200 Rush Landing Road
P.O. Box 6107
Novato, California 94948
415/892-0821
Telecopy: 415/892-1586

CHAIN OF CUSTODY FORM

Lab: ENSECO

Samplers: S. Michelle Watson

b Number: 09695.335.02

ıme/Location: VWR Boise

oject Manager: S Michelle Watson

Recorder: S Michelle Watson
(Signature Required)

CODE	MATRIX: Water	Sediment	Soil	Oil	#CONTAINERS & PRESERV.: Unpres.	H_2SO_4	HNO_3	SAMPLE NUMBER OR LAB NUMBER: Yr	Wk	Seq	DATE: Yr	Mo	Dy	Time	STATION DESCRIPTION/ NOTES	ANALYSIS REQUESTED: EPA 601/8010	EPA 602/8020	EPA 624/8240	EPA 625/8270	Priority Pllnt. Metals	Benzene/Toluene/Xylene	Total Petrol. Hydrocarb.
3	X				3			91	09	12 01	91	09	12	1015		X						
3	X				3			91	09	12 02	91	09	12	1130		X						
3	X				3			91	09	12 03	91	09	12	1140		X						
3	X				3			91	09	12 04	91	09	12	1150		X						

LAB NUMBER: Yr	Wk	Seq	DEPTH IN FEET	COL MTD CD	QA CODE	MISCELLANEOUS
						STANDARD TAT

CHAIN OF CUSTODY RECORD

RELINQUISHED BY: (Signature) S Michelle Watson	RECEIVED BY: (Signature)	DATE/TIME
RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
DISPATCHED BY: (Signature) DATE/TIME	RECEIVED FOR LAB BY: (Signature) 9-13-91 0810	DATE/TIME
METHOD OF SHIPMENT		

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QUALITY CONTROL REVIEWER

Eric G. Williams
Senior Hydrogeologist